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RAIN GARDENS – AS A WAY TO SUSTAINABLE MANAGEMENT OF RAINWATER IN THE CITY

Rain gardens are an innovative solution that fits perfectly into the idea of sustainable urban development as an example of effective stormwater management. They serve aesthetic, biocentric functions. The rain garden in a container in the College of Natural Sciences on the occasion of Landscape Day is an example of a practical application of this concept. This initiative, proposed by the Student Landscape Research Club, in collaboration with Saba Gardens, aims to educate the local community. It shows the benefits of creating rain gardens as an element of small water retention. It performs a research function, enabling students and staff of the University to analyse seasonal changes in vegetation or the technical durability of the module, as well as the interaction between the environment and users of the public space.

Keywords: rain garden, bioretention, climate changes, Rzeszow

OGRODY DESZCZOWE – JAKO SPOSÓB NA ZRÓWNOWAŻONE GOSPODAROWANIE WODĄ OPADOWĄ W MIEŚCIE

Abstrakt: *Ogrody deszczowe stanowią innowacyjne rozwiązanie, które doskonale wpisuje się w ideę zrównoważonego rozwoju miast, jako przykład efektywnego zarządzania wodami opadowymi. Pełnią funkcje estetyczne i biocenotyczne. Ogród deszczowy w pojemniku w Kolegium Nauk Przyrodniczych z okazji Dnia Krajobrazu, jest przykładem praktycznego zastosowania wspomnianej koncepcji. Inicjatywa ta, zaproponowana przez Studenckie Koło Naukowe Krajobrazy, we współpracy z firmą Saba Gardens, ma na celu edukację lokalnej społeczności. Pokazuje korzyści płynące z tworzenia ogrodów deszczowych jako elementu małej retencji wodnej. Pełni on funkcję badawczą, umożliwiając studentom i pracownikom Uniwersytetu analizę sezonowych zmian roślinności czy trwałości technicznej modułu oraz interakcji między środowiskiem a użytkownikami przestrzeni publicznej.*

Słowa kluczowe: ogród deszczowy, bioretencja, zmiany klimatu, Rzeszów

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I. INTRODUCTION

Climatic problems of cities have become one of the most important challenges of the modern world. Urbanization and human activity significantly affect the local and global environment [Wojtal 2018]. Improper water management, river drainage systems, and waste of rainwater are some examples of activities that are crucial for the water cycle in the natural environment. Numerous impermeable surfaces in cities have a negative impact on the climate and significantly reduce the retention capacity in river basins. This has contributed to an increase in the intensity and frequency of floods. River regulation and unnatural water reservoirs have changed the nature and course of many rivers. Water retention has also decreased, and rainwater has limited opportunities to infiltrate deep into the soil profile. These adverse phenomena enhance the effect of drought. Therefore, it has become important to collect rainwater, and one way of dealing with the problem of its retention and management it is to introduce bioretention systems [Domanowska and Kostecki 2015]. They provide opportunities to increase the surface area absorbing water in cities. The sustainable stormwater management system is a set of modern technical solutions that enable effective drainage of stormwater from urban areas in a more environmentally friendly way than traditional engineering methods. By integrating a variety of measures, these systems also reduce water pollution and the risk of overloading rivers and lakes with excessive water inflows. Bioretention infrastructure systems include, among others, rain gardens [Mioduszewski 2011, Bogacz et al. 2013, Wagner and Krauze 2014].

Below are examples of rain gardens that have been operating in Europe for a long time. (Fig. 1 and Fig. 2).

[Rain Garden … 2021]

Fig.1. Rain Garden at the building 'Blok 54' in Amsterdam, the Netherlands

Ryc. 1. *Ogród deszczowy przy budynku 'Blok 54' w Amsterdamie, Holandia*

[Wilson 2019]

Fig. 2. Rain Garden at the Royal Botanic Garden in Edinburgh, Scotland

Ryc. 2. *Ogród deszczowy w Królewskich Ogrodach Botanicznych w Edynburgu, Szkocja*

The aim of the work was to describe the assumptions of the rain garden and its types. It also presented the individual stages of implementation of the rain garden made at the initiative of students from the Science Club "Landscapes" at the University of Rzeszów.

II. MATERIALS AND METHODS

The rain garden project and its implementation were created as part of the preparations for Landscape Day. The literature review for the article included materials on the principles of creating such assumptions. The content of official websites presenting examples of implementation was also reviewed.

All elements of the presented project and its photographic documentation are related to the article authors' own work.

III. RESULTS

What is a Rain Garden?

A rain garden can be considered as one of the forms of land arrangement or one of the forms of water gardens and a sustainable water retention system. It has multiple functions and should be aesthetic and functional. It belongs to the blue-green infrastructure systems. The main role of a rain garden is to drain rainwater from impermeable surfaces such as roofs, squares, parking lots, roads. Another function is also to retain this water and gradually infiltrate it in the root zone. Due to its specific structure and appropriate selection of plants, it is also possible to partially purify the accumulated water. In addition, the proper selection of plant species has a positive effect on the durability and aesthetics of such a layout. [Długozima 2009, Bogacz et al. 2013, Suchocka and Siedlecka 2017, Czerniakowski and Gargała-Polar 2020].

In a rain garden, plants are selected based on their habitat and resistance to drought or periodic flooding in the ground. The plants that do best in such conditions are hydrophilic plants. It is important that their composition at planting be random and natural; these include: blue sedge (*Carex flacca*), Siberian iris (*Iris sibirica*), marsh marigold (*Caltha palustris),* marsh meadowsweet (*Filipendula ulmaria*), marsh forget-me-not (*Myosotis scorpioides)* [Dussaillan et al. 2004, Czerniakowski and Gargała-Polar 2020].

Types of Rain Gardens

The type of rain garden depends on its location. Considering the type of substrate, we can distinguish between gardens established directly in the ground (dry and wet) and in a container. A rain garden in the ground resembles a regular garden in appearance; it differs in the substrate and the composition of plant species. It is a developed area located in a shallow depression of a relatively small area, which receives rainwater from one or several nearby impermeable surfaces, such as roofs or parking lots. Regardless of the type of garden, the substrate should consist of a mixture of coarse sand, absorbent materials (such as expanded clay, dolomite aggregate, brick, bark) and soil. Wet gardens and gardens in a container. Wet gardens are best made when the ground is impermeable or has limited water infiltration. It should be noted that such a garden should be equipped with an emergency overflow to drain excess water. A garden in a container is most often established on small surfaces. It is recommended that such a garden be located near the gutter outlet and at least 30 cm from the building. Infiltration garden - in more permeable soil [Długozima 2009, Suchocka and Siedlecka 2017, Czerniakowski i Gargała-Polar 2020].

An in-ground rain garden should be designed in a 95 cm deep trench. If we are creating a garden lined with foil, we must remember to remove sharp objects from the trench. We cover the bottom with foil adapted for water features. In both the infiltration and foil-lined gardens, we pile up a 20 cm layer of dolomite. Then, we should set a drainage pipe connected to the overflow pipe. The drainage pipe should have a 1-2% slope towards the drain. In the foil-lined garden, we should cut the foil at the pipe outlet and attach a sleeve and seal. We cover the pipe with a 10 cm layer of dolomite, and then cover it with a 45 cm layer of coarse sand with the addition of other aggregates, e.g. volcanic tuff, crushed brick, limestone aggregates, rock. We cover the top layer with decorative aggregate after the planting is done [Sędzimir Foundation 2021 a and b].

A container garden can be used directly next to a building, maintaining a distance of 30 cm from the facade. Its task is to collect water from the roof of a building or a shelter. Its size depends on the roof area.

The mulch layer on top is designed to retain moisture and improve aesthetics. The soil stores rainwater and filters it into the drainage layer, which is why it is so important to be permeable. Drainage is used to drain water into the storage layer in the form of expanded clay.

Implementation of a Rain Garden at the University of Rzeszów

The designed rain garden was created on the initiative of the Science Club "Landscapes", in cooperation with the company Saba Gardens – Garden Design and Implementation and the Landscape Architecture Studio of the University of Rzeszów. The official presentation of the project took place on October 21 on the occasion of Landscape Day. The garden is located at the main entrance to the D3 building, at 1A Ćwiklińska Street in Rzeszów.

It consists of 2 concrete boxes, stylized as wood, in a color scheme similar to that of the facade. The materials used and the thickness of the individual layers are shown in Fig. 3a and 3b.

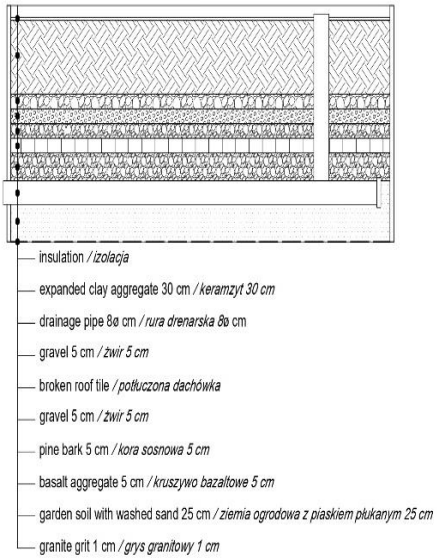

Fig. 3a. Cross-section through the upper box
Ryc. 3a. *Przekrój przez skrzynię wyższą*

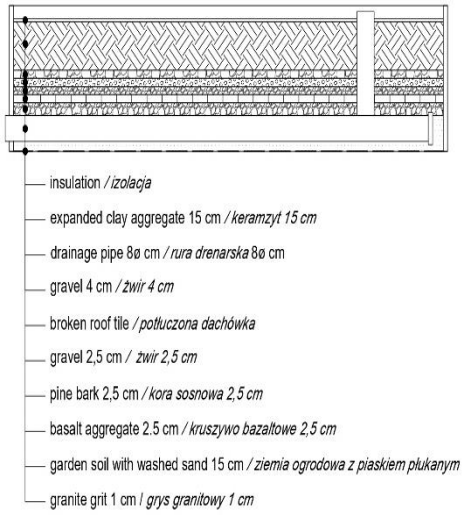

Fig. 3b. Cross-section through the lower box
Ryc. 3b*. Przekrój przez skrzynię niższą*

The first stage of the project consisted of collecting the appropriate materials and preparing the site for construction. The area where the boxes are located was thoroughly cleaned. Wooden boards, aggregates and plants were brought to the construction site. The implementation was started by screwing together the previously prepared boards. Insulation was then attached to the bottom, and the appropriate type of aggregate was poured in successively, taking into account the thickness of the layers of the given material.

A report on the construction stages is shown in Fig. 4.

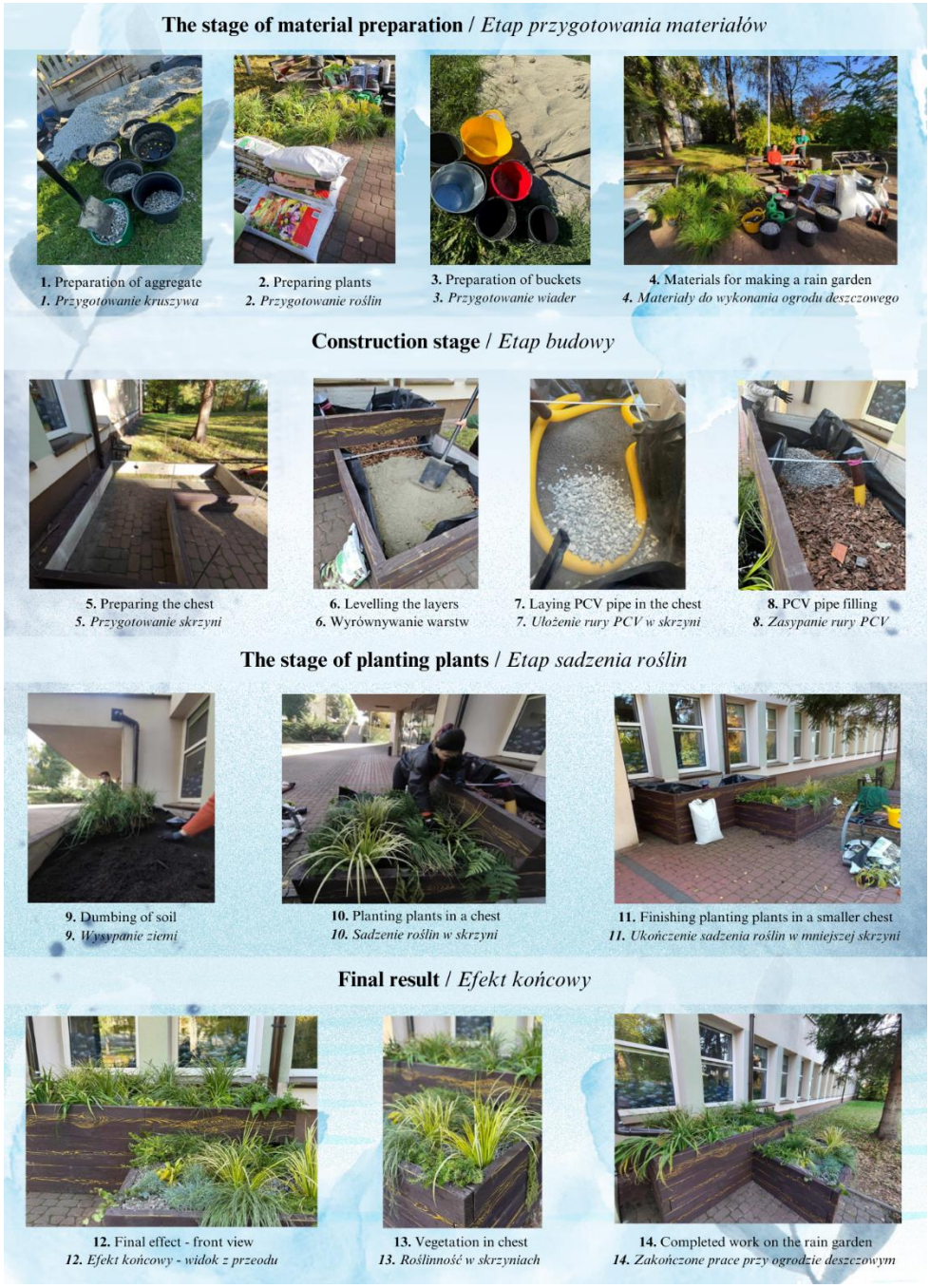

Fig. 4. The stages of realization a rain garden at 1a Ćwiklińska in Rzeszów
Ryc. 4. *Etapy realizacji ogrodu deszczowego przy ulicy Ćwiklińskiej 1a w Rzeszowie*

An important element of the garden is a pipe that drains excess water, placed at the bottom of the pot, on a layer of expanded clay. An overflow pipe was placed above the ground surface, protecting water from overflowing through the top of the pot. The final layer is a mixture of sand and garden soil, in which plants resistant to difficult conditions, as well as periodic droughts and excessive flooding were planted.

The plant species used in the project are: Morrow's sedge 'Ice Dance' (*Carex morrowii*), Siberian iris (*Iris sibirica*), water mint (*Mentha aquatica*), torch lily 'Flamenco' (*Kniphofia uvaria*), torch lily 'Poco citron' (*Kniphofia uvaria*), Hosta 'Independence' (*Hosta*), Clove pink (*Dianthus gratianopolitanus*), daylily 'Red Rum' (*Hemerocalis hybrida*), Hemerocalis hybrida (*Tatarian honeysuckle*), male fern (*Driopteris filix-mas*), soft shift fern (*Polystichum setiferum*), Monarda (*Monarda*), common ivy (*Hedera helix*), Japanese sweet flag (*Acorus gramineus*) [Filipczak 2016, Młoźniak 2024].

IV. CONCLUSIONS

Rain gardens are an important element of the landscape of modern cities. As one of the effective ways to combat drought and adverse climate, they are part of blue-green infrastructure systems as bioretention elements. While remaining spatial arrangements, they influence the improvement of aesthetic values, especially in the most concreted spaces.

The rain garden presented in the work is so far the only such facility at the University of Rzeszów and one of the few in the city itself. There are plans to continue research on the seasonal changes in vegetation in this garden and the purpose of using it as a retention surface. Observing and documenting changes in the garden will help provide data that can support more sustainable and effective design of green urban spaces.

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